AD-A176 428

DLA ECONOMIC RETENTION/RETURNS LIMITS STUDY

DEPARTMENT OF DEFENSE

DEFENSE LOGISTICS AGENCY

Operations Research and Economic Analysis Office

Cameron Station
Alexandria, Virginia 22304-6100

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SEPTEMBER 1986

DLA ECONOMIC RETENTION/RETURNS LIMITS

September 1986

Captain Ronald A. Kirchoff, USAF
Mrs. Mary Kay Cyrus
Operations Research and Economic Analysis Office
Headquarters, Defense Logistics Agency
Cameron Station, Alexandria, Virginia 22304-6100

DEFENSE LOGISTICS AGENCY
HEADQUARTERS
CAMERON STATION
ALEXANDRIA, VIRGINIA 22314

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FOREWORD

The Defense Logistics Agency is required by Department of Defense Instruction (DoDI) 4100.37, Retention and Transfer of Materiel Assets, to develop limits on the amount of stock held above that required for normal day-to-day operations. While DoDI 4100.37 provides for several categories of stock, the one studied here is economic retention stock.

This analysis determines the maximum amount of stock for which it is more economical to hold the stock in anticipation of some future demand than to dispose of the stock and risk having to reprocure it to meet future demand.

The results of the analysis indicate that the current limits may be too high for those items with higher unit prices and too low for less expensive items.

ROGER C. ROY
Acting Assistant Director
Policy and Plans

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EXECUTIVE SUMMARY

The Department of Defense Instruction (DoDI) 4100.37, Retention and Transfer of Materiel Assets, specifies policies for the retention and transfer of materiel assets. The instruction allows for the stratification of wholesale stock into several levels, one of which is economic retention. The economic retention limit specifies the amount of stock that should be retained to meet future peacetime demand for purely economic reasons. The Defense Logistics Agency currently uses an average limit of 10 years worth of stock measured at the current demand rate.

This analysis uses a breakeven equation to determine the maximum amount of stock that should be retained for economic reasons. The equation balances the two alternatives available: (1) to incur the cost to hold the stock until it is used or (2) to dispose of the stock and take the chance that it may have to be reprocured to meet a future demand. When the expected cost incurred to hold the stock equals the expected cost to dispose and reprocure, the economic retention limit has been reached.

The economic returns limit was also investigated. The same analysis is performed for the returns limit, except that the expected cost to hold is increased by the cost to return the item to the wholesale depot.

The results of the study indicate retention/return limits are dependent on the disposal cost and returns cost, where applicable. The analysis supports setting various economic retention/returns levels based upon the unit cost of an item and the expected remaining life of the item. The study recommends: (1) lower retention limits for those items with higher unit prices, and (2) extended limits for those items with lower unit prices. For less expensive items the returns limits is lower than the retention limit due to the inclusion of the cost of returning an item in the holding cost calculation.

During the course of this project other issues affecting the retention/returns policy were surfaced. These include special provisions for weapons system items and for items which have intermittent demand patterns. These issues were beyond the scope of this study but should be considered for future research.

I. INTRODUCTION

A. Background. Department of Defense Instruction (DoDI) 4100.37, Retention and Transfer of Materiel Assets[1], specifies policies for the retention and transfer of materiel assets. The retention policy stratifies wholesale assets into several categories. One of these levels is for economic retention stock. The Defense Logistics Agency Manual (DLAM) 4140.3, Materiel Management Manual[2], states that economic retention stock is determined by computing an economic retention limit which represents the maximum level of stock that could be economically justified to meet future peacetime demands. Economic retention limits are commonly referred to in terms of years or years worth of stock. This terminology actually indicates a quantity of stock determined by current annual demand levels. DLA currently uses an average economic retention limit of 10 years worth of stock at current demand levels. This limit can vary by commodity or by Federal Supply Class (FSC), if appropriate. The current limit was established in 1982 in response to DoDI 4100.37.

B. Purpose. The DLA Directorate of Supply Operations requested the DLA Operations Research and Economic Analysis Office to evaluate DLA's implementation of the DoD Directive and to propose recommendations, if necessary, for improving retention limits for DLA wholesale stocks.

C. Objective. In the determination of an economic retention limit, one is given two options. Stock can be held or that stock can be disposed. In order to decide between these options, one must know the costs associated with holding stock or disposing of it and reprocuring at a later date, if necessary. Identification of relevant costs then allows one to determine at what stock level it becomes more economical to dispose of stock than to hold. The costs of accepting additional materiel into the system by means of a return must also be considered when weighing holding costs against probable reprocurement costs. The objective of this study is to identify those maximum stock levels which can be considered as an economic retention limit and an economic returns limit for DLA wholesale stock. Proposed methods of implementation will also be considered.

D. Scope

1. The development of economic retention limits were examined for all DLA-managed items except subsistence, fuels, and new items.

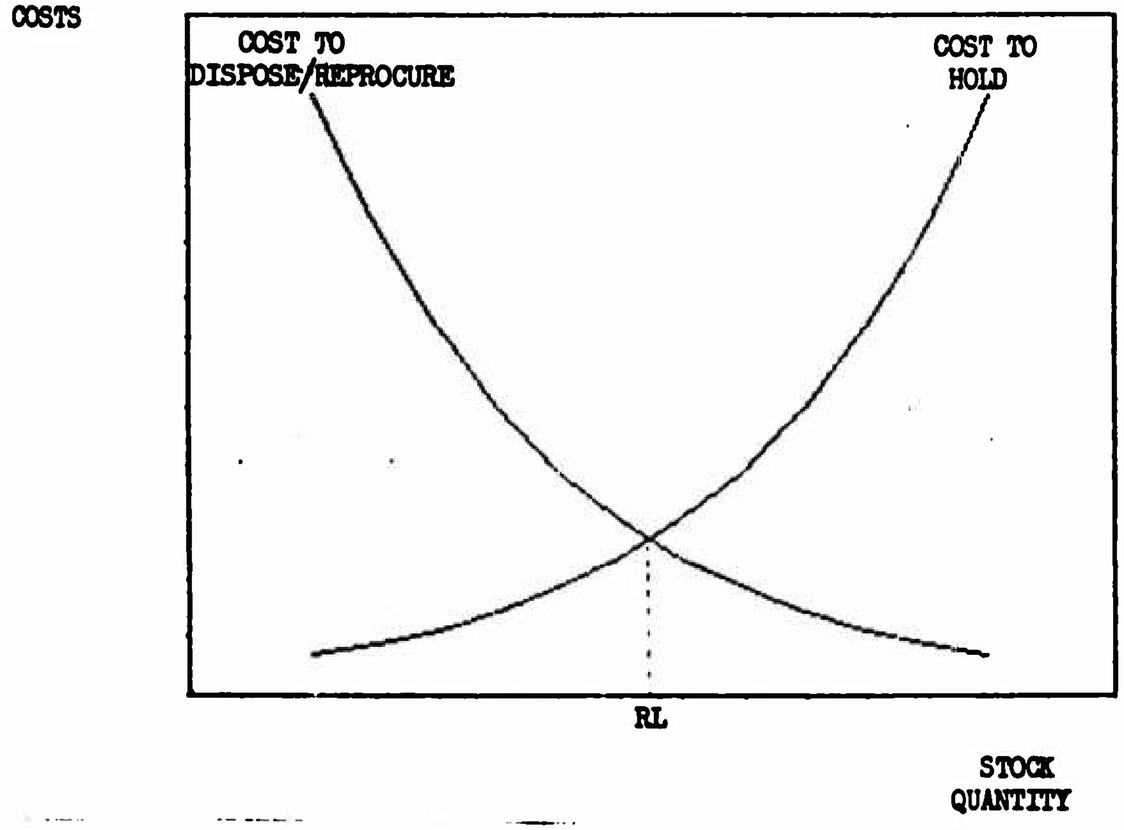
2. Possible variations in economic retention limits were investigated for replenishment demand items, numeric stockage objective (NSO) items, insurance items, and retail customer stock returns.

II. METHODOLOGY

The retention decision basically involves a balancing of costs versus the benefits of retaining material in the inventory. Simply put, this decision involves a trade-off between: (1) disposing of the assets and reprocuring them when needed, and (2) retaining the assets for future issues and avoiding future reprocurement costs. In the DLA environment, the costs to hold assets are very low compared to the costs of reprocuring them. Therefore, it is usually economical to retain some level of assets in the inventory. However, retaining a unit of stock does not automatically equate to saving the cost of a reprocurement. Demand for the item may cease before the unit is needed in which case retaining it would not have saved anything at all. The time value of money must also be considered; the unit of stock may not be needed until many years in the future, and a hundred dollars saved 10 years from now is not worth as much as a hundred dollars saved today. The question then is at what level of stock do the costs to hold an item equal the costs of disposing of the item and reprocuring it when needed. This question is complicated by the fact that future demand is unknown. Consequently, the costs associated with holding or disposing of the item are also unknown. Even with this uncertainty, however, as the amount of stock retained is increased the expected costs of holding these assets will increase. Conversely, as the stock retained is increased, expected reprocurement costs will decrease as the chance of exhausting the stock and having to procure the item decreases. This concept is shown in the graph below.

Figure 1

EXPECTED COSTS



The point at which the two lines cross is the amount of stock at which the costs of retaining the material in the inventory equal the costs associated with disposal and possible reprocurement; that is, the economic retention level.

The economic retention model developed for this study evaluates the expected holding costs versus the disposal and reprocurement costs for various amounts of stock over the next 25 years. The expected costs are evaluated by means of a breakeven equation. The stock quantity being evaluated is originally set at one years worth of demand for the item at its current demand rate. (This increment, a years worth of demand, was chosen because DLA currently measures retention limits in years worth of current demand). If the expected holding costs for the item are less than the expected costs associated with disposal and reprocurement, then the stock quantity is increased by a years worth of demand and the costs are reevaluated. These incremental increases are continued until the breakeven point is breached, i.e., holding the additional stock is more costly than not holding it.

The development of a returns limit was similar to the development of the retention limit except the cost of returning the item to the inventory was also considered.

Development of the breakeven equation required the identification of relevant cost factors and their appropriate values, a determination of required item data, and the development of demand probabilities. A detailed description of each of these components and the development of the breakeven equation follows.

A. Cost Factors

The cost factors identified for use in the economic retention model were: storage cost, disposal cost, returns cost, and reprocurement cost. The equations used to derive the cost values for these factors can be found at Appendix A.

1. Storage Cost. The storage cost currently used throughout DLA is computed as one percent of an item's unit price. There has been some controversy concerning the accuracy of this one percent rate. Cost data from the RCS-48 Report, FY85, for Depot Operations were used to recompute this value. These data reconfirmed the one percent storage cost rate used in this study.

2. Disposal Cost. For each disposal action, there is a one-time cost incurred by DLA to process and transport an item for disposal, a cost to Defense Reutilization and Marketing Service (DRMS) to receive and process the disposal, and a realized salvage value. The processing costs to DRMS and the realized salvage value will be referred to as the net disposal rate for DRMS. This net disposal rate has been calculated as 10.4% of an items's unit price. The DLA Depot Operations Division (DLA-OW) identified the cost per line to DLA to be $5.31. The sensitivity of the breakeven equation to DLA disposal cost was tested for values of $0.67, $2.15, $5.31, and $10.49. A review of disposal actions for FY85 showed the median number of items per line was eight. Therefore, the minimum cost tested represents an estimated disposal cost per unit.

3. Returns Cost

The cost to return an item is considered to be a one-time cost which includes administrative, receipt, and item management costs incurred by DLA. Various sources exist for this cost data, but each cite a different value. The interim report for the DoD Material Returns Study[3] identifies a cost range from $10.00 to $13.00 as the cost to return. This range was derived from input received from the Services and DLA concerning their independent assessments of returns cost. The DLA-OW identified the cost per line to process a return as $10.22.

A cost to return was only employed in the economic retention model when determining the economic returns limit. The sensitivity of the breakeven equation to changes in returns cost was tested for values of $2.04, $4.58, $10.22, and $15.00. A review of return quantities accepted during FY85 identified the median number of items per line to be five. Therefore, the minimum cost tested represents an estimated returns cost per unit.

4. Reprocurement Cost. For any procurement action, there is an associated administrative cost to order along with the purchase price of the item. The average cost to order was identified as $90.75 (Cost to Order Study, May 1984[4]). The purchase price of an item can be very dependent upon quantities ordered, requirements for manufacturer setup, demand patterns, etc.. This dependency upon conditions when reprocuring results in premium pricing. No trackable pattern for premium pricing has been identified although repurchase prices ranging from 100%-400% of the original purchase price have been noted. Sensitivity analyses were performed to determine the effect of these variabilities in repurchase prices. The original purchase price of an item was used in the final analysis.

The time value of money was also considered. Each developed recurring cost represents a projected future cost incurred in each year throughout the planning horizon. These future costs were discounted back to the base year using present value formulas. A discount factor of .10 was used in accordance with DLA and DoD directives.

B. Item Data Requirements

The Item data files from the DLA Integrated Data Bank were screened for current active items. One percent random samples were selected for each commodity. All analyses were performed on a commodity basis.

With the exception of demand probability development, the only item data element not readily available was the item's expected remaining life in the system. In order to calculate an item's expected remaining life, it was necessary to know the expected system life of the item. No estimate of the technological life of DLA items was readily available. For the purposes of this study, estimates of item lifetimes were obtained by selecting those items on the Supply Control File that were identified for deletion from the inventory during FY82, 83, and 84. The total time these items were in the system was calculated and then averaged across each FSC. A standard deviation for the observations from each FSC was also calculated. The average and standard deviation then were used to estimate the system life for all items in that FSC. Three standard deviations were used to ensure a conservative estimate.

Within the economic retention model, an item's expected remaining life is computed as follows:

$$REML = (FSCAVG + 3*FSCSTD) - CURLIFE$$

where: REML = remaining life in the system
FSCAVG = average expected life for an item in the FSC

FSCSTD = standard deviation of the computed FSCAVG
CURLIFE = an item's time in the system to date
= Current Date - System Entry Date

C. Demand Probabilities

The economic retention model used in this study is very dependent upon the probability that demand over an extended period will exceed the proposed retention stock. The approach taken was developed in a previous study conducted by the DLA Operations Research and Economic Analysis Office in 1978 [5]. That report stated "DLA has never maintained an item demand history of sufficient length to be able to predict long-term demand trends." Unfortunately, this is still the case today and, as a result, the development of estimates of the probabilities of demand are mainly theoretical.

The cumulative probability that demand would exceed the proposed retention stock was calculated for each year in the 25 year in the planning horizon. These cumulative probabilities were then used to determine the probability that a stockout would occur in a given year.

The model also assumes that retention decisions are most likely to occur during the latter portion of the life of an item when the demand rate decays as the item is replaced by improved technology or new programs. The model uses an exponential decay rate such that the demand for the item decays to ten percent of its current level by the time it reaches the end of its expected life. This assumption highlights the fact that economic retention limits are not applicable to highly active items experiencing growing or constant demand patterns.

A detailed derivation of the demand probabilities is presented in Appendix B.

D. Development of Breakeven Equation

After the cost factors and the demand probabilities were established, the breakeven analysis equation was developed to determine the economic retention limit. The retention decision involves a trade-off between retaining assets for future issue and disposing of assets and taking the chance of reprocuring them in the future. Each side of the breakeven equation corresponds to one of the options. The left side of the equation corresponds to the decision to hold the stock while the right side quantifies the decision to dispose of the item now and take the chance it will have to be reprocured in the future. The various parts of the equation are depicted below.

Hold Decision vs. Dispose/Reprocure Decision (1)

Expected Holding Cost=Expected Reprocurement Cost-Return from Disposal (2)

The expected holding and reprocurement costs are summed over the 25-year planning horizon. Because demand is uncertain, the holding cost for each year is weighted by the probability that the stock has not been exhausted or the probability of having stock on hand. Similarly, the reprocurement costs are weighted by the probability that a stockout occurs in a given year. When these terms are added and the previous terms are expanded into each of their components equation (2) becomes:

$$\sum_{j=1}^{25} [(SRATE*SP)*PSOH_j] = \sum_{j=1}^{25} ((RPRATE*SP+RPCOST))*PSOUT_j-[(DRATE*SP)-DCOST] \quad (3)$$

where: SRATE = storage cost rate
SP = item unit price
$PSOH_j$ = probability of stock on hand in year j
= $1-P_j$
where P_j = probability that total demand exceeds stock on hand in years 1 through j

RPRATE = premium pricing rate
RPCOST = one-time cost to order
$PSOUT_j$ = probability of a stockout in year j
DRATE = net disposal rate (DRMS)
DCOST = DLA disposal cost

Finally, each of the costs in years 2 through 25 are multiplied by a discount factor to adjust these costs to present year dollars. This term is omitted in the equations shown here for the reason of clarity.

The returns breakeven equation was developed in a similar fashion. The decision facing the wholesale manager in the returns situation is whether to accept a return and the associated costs of bringing the item back from the retail level or deny the return request and take the chance he will have to procure the item in the future. When we consider the costs associated with this decision at the retail level one of two costs will be incurred. Either the return will be accepted and the retail level will incur a cost to ship the item to the wholesale level or the return will be denied and the retail level may incur a cost to process the item for disposal. It is assumed that these costs would vary among the various retail locations but the cost for either outcome, prepare for return or disposal, would essentially be the same for the retail customer and, therefore, they are not included in the returns breakeven equation.

The left side of the returns breakeven equation is similar to the retention equation except that the cost to DLA of accepting the returned item into stock is added to the expected holding cost. The right side of the equation remains the same. The resulting equation is shown below.

$$RTNCOST+ \sum_{j=1}^{25} [(SRATE*SP)*PSOH_j]= \sum_{j=1}^{25} (RPRATE*SP+RPCOST)*PSOUT_j-[(DRATE*SP)-DCOST]$$

where RTNCOST = Cost the accept the return into the inventory and all other terms are as defined above.

The breakeven retention equation was used to determine at what stock level the total expected holding cost over a given time horizon (25 years) exceed the net disposal cost and the total expected reprocurement cost for the same time horizon. The computed probabilities of stockout are a function of the stock quantity being tested. The incremental increases in stock being evaluated are maintained by counters within the economic retention model. Appendix C presents a flowchart depicting the overall model logic of the economic retention model.

E. Sensitivity Analyses

As with any question of economics, the costs employed may have significant impacts upon the results. Sensitivity analyses were performed by varying the estimated returns cost, disposal cost, and premium price rate for reprocurement.

The computed remaining life of an item also impacts the results of the breakeven equation due to its use in computing the exponential decay rate for demand and the demand probabilities. There are some items currently active in the system whose life has already exceeded the computed average life for an item in its FSC. Given its current status, there should exist a minimum remaining life for that item. Several minimum levels were tested. A minimum remaining life of three years was used in the final analysis.

F. Implementation Methodology

Previous studies on economic retention limits for DLA wholesale stock have employed methodologies similar to those used in this study. However, methods of implementation have usually resulted in the use of an overall or commodity average retention limit being applied to all items. This study attempted to develop an improved implementation strategy which will more accurately portray the study results.

The addressed strategy involved performing regression analyses on item data inputs within the model to identify those variables highly correlated with the resultant economic retention limit. Once these factors were identified, the predictive equation was used to generate "look-up" tables for selecting an item's retention limit based upon identifiable characteristics. An item's unit price and remaining life were found to be the most influential factors in determining the retention limit. The regression results are presented in more detail in the next section.

III. ANALYSIS RESULTS. Initial analysis using the economic retention model produced information for average retention limits on a commodity basis. Within each commodity, items were categorized as replenishment, NSO, and other. Additional statistical analyses for frequencies of computed retention limits and the minimum and maximum unit price of items within each retention limit were performed.

A. Sensitivity Testing

1. Disposal Costs

This first step in the sensitivity analysis identified the impact of the one-time costs of disposal on the retention decision with regard to the one percent storage cost rate. Dependent upon the disposal cost, a unit price breakpoint is established. If an item's unit price falls below this breakpoint, the analysis determines that it is more economical to hold all stock rather than incur disposal costs. Due to these strictly economic considerations, remaining life and the probability of demand may never come into play in the breakeven equation. The separate categories of replenishment, NSO, and other displayed no appreciable differences in their computed retention limits.

The next step in the analysis again identified the average computed retention limit for all items but also identified the unit price breakpoint, the number of items with unit prices greater than this breakpoint, and the average computed retention limits for these items. Results of this analytical step are presented in Table 1. For example, when a DLA disposal cost of $5.31 was tested for the General commodity, the overall average computed retention limit was 16.86 years worth of current demand; the 966 NSNs with unit price less than or equal to $28.48 had retention limits of 25 years; and the average computed retention limit for the remaining 822 NSNs with unit price greater than $28.48 was 7.30 years worth of current demand.

The results for all commodities show a large difference between the overall average and the average for those items with less than a 25 year limit. This result may be attributed to a combination of several factors. The first of these is that a large percentage of items in each commodity fall into the price range where the cost to dispose of the item is greater than the cost to hold the item indefinitely; consequently, due to the selected planning horizon, the model assigns a 25 year retention limit. For those items that do not fall into this category, two factors: (1) the assumption of an exponential decay rate, and (2) the high number of items with relatively short remaining life, tend to lower the retention limit.

The unit price breakpoints presented in Table 1 are dependent upon the commodity sample. For follow-on sensitivity analyses, 'standard' breakpoints were computed algebraically.

2. Returns Cost. The returns cost were set at four levels: $2.04, $4.58, $10.22, and $15.00. The computed returns limits for each commodity are presented in Table 2. The overall average returns limits show some sensitivity to the return cost used. The unit price breakpoints discussed above occur in the returns limits only when the disposal cost exceeds the return cost (see Table 2b).

3. Premium Pricing

For the General commodity, the effect of changing the premium pricing rate was analyzed. The cost to procure an item in future years was increased to 150%, 250%, and 400% of its present unit price. The results of this testing are presented in Table 3. Disposal costs are $5.31. Each cell of the matrix presents the overall retention calculated for all items in the sample, the

Table 1

EFFECT OF DISPOSAL COST
ON COMPUTED RETENTION LIMITS
AND UNIT PRICE BREAKPOINTS

COMMODITY\ DISPOSAL (TOTAL) \COST	$0.67*	$2.15	$5.31	$10.49	
CONSTRUCTION (2959)	8.10	11.11	14.38	16.93	OVERALL AVG RL
	2554	2094	1589	1205	# < 25 YRS
	5.42	5.38	5.23	5.18	AVG WHEN < 25 YRS
	3.42	11.03	27.26	53.5	MAX UNIT PRICE
ELECTRONICS (6479)	12.52	15.95	18.64	20.55	OVERALL AVG RL
	4663	3318	2307	1607	# < 25 YRS
	7.67	7.33	7.15	7.05	AVG WHEN < 25 YRS
	3.43	11.10	27.22	53.77	MAX UNIT PRICE
GENERAL (1785)	11.97	14.59	16.86	18.54	OVERALL AVG RL
	1335	1057	822	656	# < 25 YRS
	7.54	7.40	7.30	7.39	AVG WHEN < 25 YRS
	3.64	11.02	26.48	53.76	MAX UNIT PRICE
INDUSTRIAL (5938)	18.72	21.22	22.80	23.58	OVERALL AVG RL
	2655	1562	891	575	# < 25 YRS
	10.96	10.64	10.34	10.34	AVG WHEN < 25 YRS
	4.01	11.86	27.25	53.85	MAX UNIT PRICE
MEDICAL (135)	14.44	18.70	21.27	22.5	OVERALL AVG RL
	83	50	31	22	# < 25 YRS
	7.83	8.00	8.74	9.64	AVG WHEN < 25 YRS
	3.22	10.08	26.46	53.00	MAX UNIT PRICE
TEXTILE (210)	12.09	16.16	20.29	22.3	OVERALL AVG RL
	154	103	54	30	# < 25 YRS
	7.39	6.97	6.67	6.13	AVG WHEN < 25 YRS
	3.35	10.64	27.03	53.57	MAX UNIT PRICE

Table 2A

EFFECT OF RETURNS COST
ON COMPUTED RETURNS LIMITS
DISPOSAL COST = $5.31

COMMODITY \ RETURNS (TOTAL) \COST	$2.04*	$4.58	$10.22	$15.00	
	12.55	8.22	4.81	4.57	OVERALL AVG RL
CONSTRUCTION	1870	2536	2959	2959	# < 25 YRS
(2959)	5.29	5.43	4.81	4.57	AVG WHEN < 25 YRS
	16.50	3.74	0.00	0.00	MAX UNIT PRICE
	17.18	12.77	6.73	6.24	OVERALL AVG RL
ELECTRONICS	2851	4565	6479	6479	# < 25 YRS
(6479)	7.23	7.64	6.73	6.24	AVG WHEN < 25 YRS
	16.73	3.74	0.00	0.00	MAX UNIT PRICE
	15.63	12.07	7.03	6.57	OVERALL AVG RL
GENERAL	944	1323	1788	1788	# < 25 YRS
(1788)	7.25	7.52	7.03	6.57	AVG WHEN < 25 YRS
	28.48	3.74	0.00	0.00	MAX UNIT PRICE
	22.04	18.92	8.96	8.15	OVERALL AVG RL
INDUSTRIAL	1215	2577	5938	5938	# < 25 YRS
(5938)	10.52	10.97	8.96	8.15	AVG WHEN < 25 YRS
	16.71	4.01	0.00	0.00	MAX UNIT PRICE
	19.73	14.59	5.93	5.56	OVERALL AVG RL
MEDICAL	43	82	135	135	# < 25 YRS
(135)	8.47	17.85	5.93	5.56	AVG WHEN < 25 YRS
	15.85	3.44	0.00	0.00	MAX UNIT PRICE
	18.36	12.22	6.14	5.64	OVERALL AVG RL
TEXTILE	77	152	210	210	# < 25 YRS
(210)	6.90	7.34	6.14	5.64	AVG WHEN < 25 YRS
	16.56	3.56	0.00	0.00	MAX UNIT PRICE

Table 2B

EFFECT OF RETURNS COST
ON COMPUTED RETURNS LIMITS
DISPOSAL COST = $0.67

COMMODITY \ RETURNS (TOTAL) \COST	$2.04*	$4.58	$10.22	$15.00	
CONSTRUCTION (2959)	5.17	4.90	4.58	4.41	OVERALL AVG RL
	2959	2959	2959	2959	# < 25 YRS
	5.17	4.90	4.58	4.41	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE
ELECTRONICS (6479)	7.40	6.89	6.25	5.87	OVERALL AVG RL
	6479	6479	6479	6479	# < 25 YRS
	7.40	6.89	6.25	5.87	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE
GENERAL (1788)	7.60	7.17	6.59	6.22	OVERALL AVG RL
	1788	1788	1788	1788	# < 25 YRS
	7.60	7.17	6.59	6.22	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE
INDUSTRIAL (5938)	10.01	9.17	8.16	7.57	OVERALL AVG RL
	5938	5938	5938	5938	# < 25 YRS
	10.01	9.17	8.16	7.57	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE
MEDICAL (135)	6.44	6.08	5.57	5.34	OVERALL AVG RL
	135	135	135	135	# < 25 YRS
	6.44	6.08	5.57	5.34	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE
TEXTILE (210)	6.68	6.29	5.65	5.36	OVERALL AVG RL
	210	210	210	210	# < 25 YRS
	6.68	6.29	5.65	5.36	AVG WHEN < 25 YRS
	0.00	0.00	0.00	0.00	MAX UNIT PRICE

number of items with a retention level of less than 25 years, the average retention limit for those items, and the maximum unit price of items with a 25-year limit.

Due to the low probability of issuing a reprocurement in the outyears, the sensitivity testing for premium pricing rates did not identify this as a significant factor. It is for this reason that the standard unit price of the item was used as the repurchase price.

Table 3

SENSITIVITY OF PREMIUM PRICING RATE

/Premium Category/Price Rate	1.00	1.50	2.50	4.00
Overall Avg RL	16.86	17.00	17.17	17.35
# < 25 YRS	822	822	822	822
AVG When < 25 YRS	7.30	7.61	7.97	8.37
MAX Unit Price	28.48	28.48	28.48	28.48

4. Minimum Remaining Life. For the General commodity, the effect of changing the minimum remaining life was also analyzed. The minimum remaining life was tested for 3, 5, and 10 years. Results are presented in Table 4.

Table 4

SENSIVITITY OF MINIMUM REMAINING LIFE

/Minimum Category/PREM.LIFE	3 YRS	5 YRS	10 YRS
Overall AVG RL	16.86	16.96	17.29
# < 25 YRS	822	822	822
AVG When < 25 YRS	7.30	7.50	8.23
MAX Unit Price	28.48	28.48	28.48

5. Results. Based upon the results of the sensitivity analyses, the following parameters were used for the final analysis:

Disposal Cost	=	$0.67 and $5.31
Returns Cost	=	$2.05 and $10.22
Premium Pricing Rate	=	100% of present unit price
Minimum Remaining Life	=	3 years

Due to the uncertainty in the cost figures, two values were selected to represent the range of possible values. The lower cost figures represent an estimate of the cost per unit based on the median number of units per line estimated for disposal and return actions. The higher figures represent the estimated average costs to process a return or disposal line. Results for both sets of costs are presented in order to better understand the effect of these costs.

B. Implementation Methodology

In an attempt to show how this policy might be implemented, regression analyses were performed to identify the highly correlated variables. Unit price categories based upon the price categories utilized in the DLA Summary Fractionation Reports were established as regression variables. The unit price breakpoints previously identified were incorporated within these categories. Regression results identified these unit price categories and remaining life as those factors highly correlated with the retention limit.

A regression equation was then used to develop an approximation to the retention limit calculated by the model. Table 5 presents the results of the average retention limit for each unit price category/remaining life combination. The table presented is for the General commodity.

Table 5

EXAMPLE RETENTION LIMIT MATRIX

GENERAL

UNIT PRICE / REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
\$0.01-\$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
\$3.44-\$5.00	6.06	6.80	7.55	8.29	9.03	9.77	10.51	11.25	11.99	12.73
\$5.00-10.00	4.81	5.55	6.29	7.03	7.77	8.51	9.25	9.99	10.73	11.47
\$10.01-25.00	4.12	4.86	5.60	6.34	7.08	7.82	8.56	9.30	10.04	10.78
\$25.01-50.00	3.32	4.07	4.81	5.55	6.29	7.03	7.77	8.51	9.25	9.99
\$50.01-\$100.	2.87	3.61	4.35	5.09	5.83	6.57	7.31	8.05	8.80	9.54
\$100.01-500.	2.27	3.01	3.75	4.49	5.23	5.97	6.71	7.45	8.19	8.93
\$500.01-1000.	1.88	2.62	3.36	4.10	4.85	5.59	6.33	7.07	7.81	8.55
OVER \$1000.00	1.88	2.62	3.36	4.10	4.85	5.59	6.33	7.07	7.81	8.55

Regression tables for all commodities are presented in Appendix D.

Similar regression tables for returns limits are also provided in appendix D. It is important to note that for some combinations of unit price and remaining life the return limit shown in the tables is larger than the retention limit. This occurs only in cells which represent higher unit prices. It should be expected that as the unit price of the item increases the return and retention limits would converge due to the fact that the return cost becomes relatively small when compared to the price. The return limit should never exceed the retention limit however. These unexpected results are most likely due to the fact that there are a limited number of observations in these cells and, consequently, the regression over predicts the limit. In these cases the retention limit would also serve as the returns limit.

These regression tables could be established as 'look-up' tables or indices for determining an item's retention/returns limit based upon its unit price and estimated remaining life. The question unanswered is how to best estimate the remaining life. This information may not be readily available to an item manager. However, the data used in this study to compute system lifetimes are available in the SAMMS system.

In an effort to overcome this constraint, 'actuarial-type' tables were developed in an attempt to estimate remaining life based upon the current age of an item. These tables are presented in Appendix E. This approach could be employed with minor modifications to the regression tables established. However, due to the limited data available for development of these 'actuarial-type' tables, confidence in the projected remaining lives is not high.

IV. CONCLUSIONS

A. No one overall average retention limit accurately reflects DLA item/system behavior.

B. Computed retention limits are dependent upon disposal cost. An item's estimated remaining life is also a significant factor.

C. If it is uneconomical to dispose of an item at any time due to the low storage cost rate and unit price, the retention decision is to hold all stock rather than incur disposal costs.

D. If disposals are economical, remaining life and the probability of demand in future years influence the retention decision.

E. If disposals are economical, average computed retention limits range from five to ten years worth of current annual demand, dependent upon the commodity and disposal cost.

F. Average computed returns limits range from 5 to 10 years worth of current annual demand, dependent upon the commodity and return cost.

V. RECOMMENDATIONS

The model assumes that the costs used for return and disposal are per unit costs. The best estimate of these costs were \$.67 per unit for disposal and \$2.05 for returns. These costs should be used for development of an economic retention/returns policy.

One of the most difficult aspects of this study was the development of costs for the processing of disposals and returns. The final figures used were gross averages and while these were the best available at this time, they may not accurately reflect the variable nature of the costs. Research into methods to more accurately specify these costs is recommended.

The regression based tables developed for the economic retention and returns limits should be used as guidelines to develop an economic retention/returns policy.

APPENDIX A

Development of Cost Factors

APPENDIX A

Development of Cost Factors

The equations used to derive the costs for this study are presented below. Costs were derived from the RCS-48 Report, FY85, for Depot Operations. The required item/system data were obtained from the DLA Inventory Data Bank Item data files.

1. Storage Costs

   a. Storage rate per unit \$ value = $\dfrac{\text{Total Storage Cost}}{\text{Total Asset Value of Average Stock on Hand}}$

2. Disposal Costs

   Net Disposal Revenue (DRMS) = Gross Disposal Revenue (DRMS) - Gross Operating Costs (DRMS)

   Net Disposal Rate per unit \$ Value (DRMS) = $\dfrac{\text{Net Disposal Revenue (DRMS)}}{\text{Total Asset Value of Disposed Items}}$

   Total Net Disposal Costs (System) = DLA costs to dispose - (Net Disposal Rate * \$ Value of disposed items)

The computation of Gross Disposal Revenue includes consideration of reutilized materiels at 50% of their original acquisition value.

APPENDIX B

Derivation of Demand Probabilities

APPENDIX B

Derivation of Demand Probabilities

A. Demand Patterns

One of the key assumptions made in the development of the demand probabilities is that demand rate decays as the item ages in the system.

Figure B-1 is presented as a general case for demand patterns of an item in the DLA system. Over the life of an item the demand process should pass through three stages. The demand rate will rise rapidly during the demand development period (Stage I) and level off somewhat in Stage II, where it will fluctuate around a more or less constant mean rate for some undetermined period of time. Inevitably, the demand rate will begin to decay. This is indicated in Figure B-1 as Stage III. Items that are in Stages I and II are not actual demand fails to equal the quantities procured earlier, thus bringing about a potential excess situation. [5]

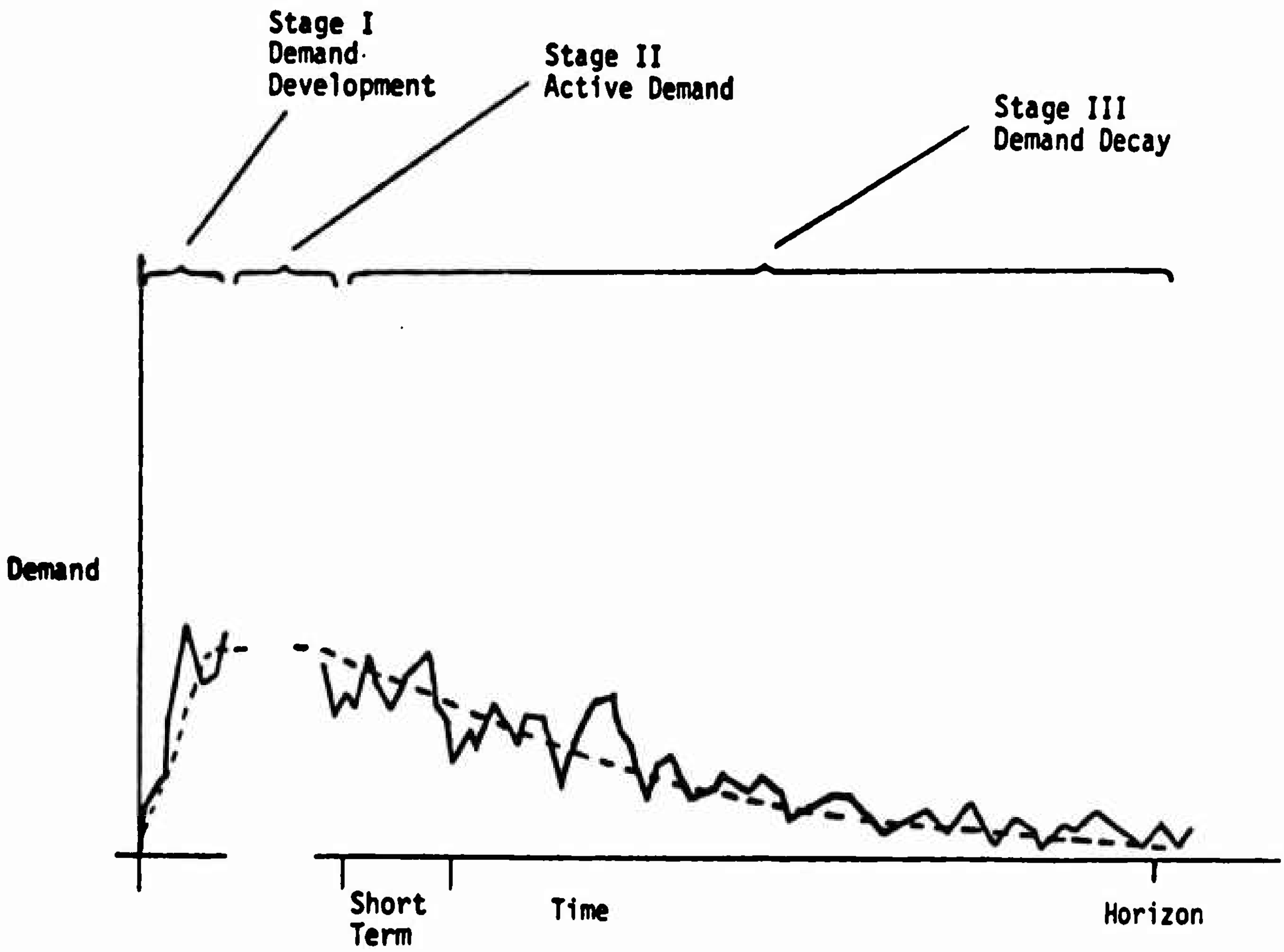


Figure B-1 Lifetime Demand Process

If it is assumed that this decay rate is exponential in nature, then the mean and variance of the demand over some horizon, H, can be expressed as:

$$\mu (H) = [D_o/r] (1-e^{-rH}) \quad (1)$$

$$\sigma^2(H) = [((\alpha+1)D_o/((2r-b)F_o]1-e^{-(2r-b)H}) \quad (2)$$

where: α is the variance to mean-square ratio of requisition size,

D_o is the current annual demand rate,

F_o is the current frequency of requisitions (requisitions/year),

r is the rate at which demand decays, and

b is the rate at which frequency decays.

Since demand over an extended period is made up by summing many individual demands, the resulting distribution of demand can be expected to approach a normal distribution in functional form.

Equations (1) and (2) can then be used to find the probability that demand over some time horizon (H) will exceed a given stock quantity.

B. Demand Probabilities

If the given stock quantity is expressed in terms of the current demand rate, D_o, times the number of years to stock on hand, y, then the probability that the random variable of total demand, X_j, exceeds the stock level, yD_o, is:

$$P = \text{Probability } (X_j > YD_o)$$

$$= N[(yD_o - \mu (H))/\sigma (H)] \quad (3)$$

where N is the complementary cumulative normal distribution function.

By substituting equations (1) and (2) into equation (3), the probability, P_j, that X_j, the random variable representing total demand over j years, exceeds some initial level yD_o becomes

$$P_j = N \left[\frac{(y-(1-e^{-rj})/r)}{[(\alpha+1)/(2r-b)F_o)](1-e^{-(2r-b)j})} \right] \quad (4)$$

where y is equal to the retention limit expressed in years worth of current annual demand.

These probabilities, the P_js, are the cumulative probabilities or the probability that demand exceeds supply in years 1 through j. The probabilities used in the model, probability of having stock on hand at the end of year j, and the probability of a stockout during a given year, are computed from these cumulative probabilities.

To determine values for each of the terms in equation (4), some further development was required. The α, F_0, and r terms in the equation are known or can be calculated.

1. The variance to mean-square ratio was calculated from the requisition history for the sample of items used in the model. The requisitions for FY84, FY85 and the Supply Control File were used to determine F_0 and calculate α.

2. The rates at which demand and frequency decay, r and b, respectively, are unknown and must be approximated. A value for r can be calculated using the estimated remaining life of the item and by expressing the mean demand rate for the item at the end of its life as a percentage of the current demand rate. For example, if the demand rate for an item at the end of its life, time L, is one-tenth the current demand rate, then the following relationship holds:

$$.10D = De^{-rL}$$

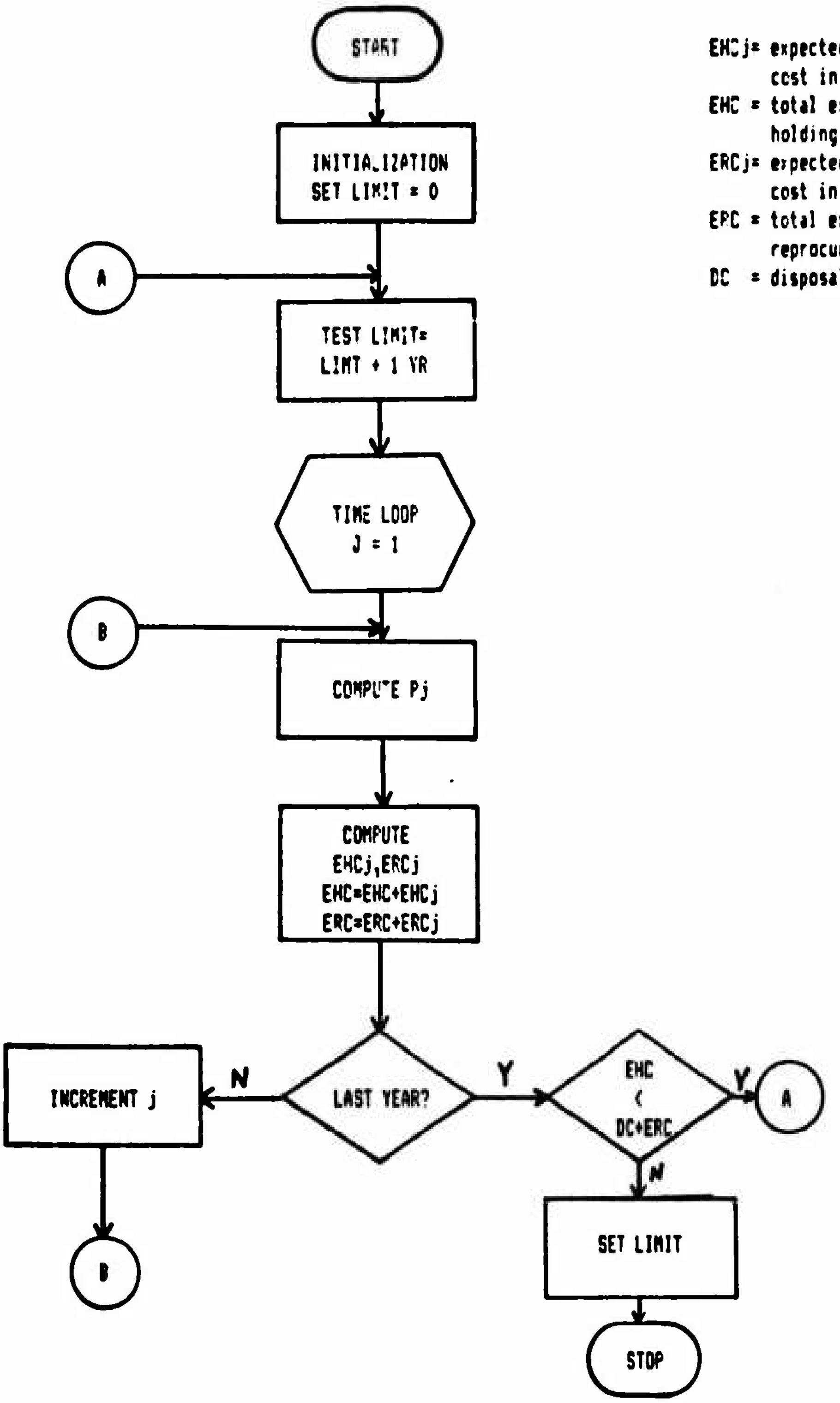
or

$$r = -(\ln .10)/L$$

APPENDIX C

Model Logic Flowchart
Economic Retention Limit Model

APPENDIX C
MODEL LOGIC FLOWCHART
ECONOMIC RETENTION LIMIT MODEL



EHCj= expected holding cost in year j
EHC = total expected holding costs
ERCj= expected reprocurement cost in year j
ERC = total expected reprocurement costs
DC = disposal cost

APPENDIX D

Regression Tables

Economic Retention Limits

ECONOMIC RETENTION LIMITS
GENERATED USING
REGRESSION RESULTS
DISPOSAL COST = $0.67

CONSTRUCTION

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	4.45	5.21	5.98	6.74	7.51	8.28	9.04	9.81	10.57	11.34
$5.00-10.00	4.12	4.88	5.65	6.41	7.18	7.95	8.71	9.48	10.24	11.01
$10.01-25.00	3.55	4.32	5.08	5.85	6.61	7.38	8.15	8.91	9.68	10.44
$25.01-50.00	2.96	3.73	4.50	5.26	6.03	6.79	7.56	8.33	9.09	9.86
$50.01-$100.	2.52	3.29	4.05	4.82	5.59	6.35	7.12	7.88	8.65	9.42
$100.01-500.	2.28	3.04	3.81	4.57	5.34	6.11	6.87	7.64	8.41	9.17
$500.01-1000.	2.09	2.86	3.62	4.39	5.15	5.92	6.69	7.45	8.22	8.98
OVER $1000.00	1.95	2.72	3.48	4.25	5.02	5.78	6.55	7.31	8.08	8.85

ELECTRONICS

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	6.13	6.92	7.70	8.49	9.28	10.06	10.85	11.64	12.43	13.21
$5.00-10.00	5.08	5.87	6.65	7.44	8.23	9.02	9.80	10.59	11.38	12.16
$10.01-25.00	4.03	4.81	5.60	6.39	7.18	7.96	8.75	9.54	10.32	11.11
$25.01-50.00	3.27	4.06	4.84	5.63	6.42	7.20	7.99	8.78	9.57	10.35
$50.01-$100.	2.76	3.55	4.33	5.12	5.91	6.69	7.48	8.27	9.06	9.84
$100.01-500.	2.26	3.05	3.83	4.62	5.41	6.20	6.98	7.77	8.56	9.35
$500.01-1000.	1.85	2.63	3.42	4.21	4.99	5.78	6.57	7.36	8.14	8.93
OVER $1000.00	1.75	2.54	3.32	4.11	4.90	5.69	6.47	7.26	8.05	8.83

GENERAL

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	6.06	6.80	7.55	8.29	9.03	9.77	10.51	11.25	11.99	12.73
$5.00-10.00	4.81	5.55	6.29	7.03	7.77	8.51	9.25	9.99	10.73	11.47
$10.01-25.00	4.12	4.86	5.60	6.34	7.08	7.82	8.56	9.30	10.04	10.78
$25.01-50.00	3.32	4.07	4.81	5.55	6.29	7.03	7.77	8.51	9.25	9.99
$50.01-$100.	2.87	3.61	4.35	5.09	5.83	6.57	7.31	8.05	8.80	9.54
$100.01-500.	2.27	3.01	3.75	4.49	5.23	5.97	6.71	7.45	8.19	8.93
$500.01-1000.	1.88	2.62	3.36	4.10	4.85	5.59	6.33	7.07	7.81	8.55
OVER $1000.00	1.88	2.62	3.36	4.10	4.85	5.59	6.33	7.07	7.81	8.55

INDUSTRIAL

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	8.25	8.87	9.48	10.10	10.71	11.33	11.94	12.55	13.17	13.78
$5.00-10.00	6.80	7.42	8.03	8.64	9.26	9.87	10.49	11.10	11.72	12.33
$10.01-25.00	5.59	6.21	6.82	7.44	8.05	8.67	9.28	9.89	10.51	11.12
$25.01-50.00	4.69	5.31	5.92	6.53	7.15	7.76	8.38	8.99	9.61	10.22
$50.01-$100.	3.79	4.40	5.02	5.63	6.25	6.86	7.47	8.09	8.70	9.32
$100.01-500.	2.75	3.36	3.98	4.59	5.20	5.82	6.43	7.05	7.66	8.28
$500.01-1000.	1.93	2.54	3.16	3.77	4.38	5.00	5.61	6.23	6.84	7.46
OVER $1000.00	0.85	1.47	2.08	2.70	3.31	3.92	4.54	5.15	5.77	6.38

MEDICAL

UNIT PRICE \ REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	4.84	5.55	6.27	6.99	7.70	8.42	9.14	9.86	10.57	11.29
$5.00-10.00	3.30	4.01	4.73	5.45	6.17	6.88	7.60	8.32	9.04	9.75
$10.01-25.00	3.30	4.01	4.73	5.45	6.17	6.88	7.60	8.32	9.04	9.75
$25.01-50.00	3.30	4.01	4.73	5.45	6.17	6.88	7.60	8.32	9.04	9.75
$50.01-$100.	2.34	3.06	3.78	4.49	5.21	5.93	6.65	7.36	8.08	8.80
$100.01-500.	2.20	2.92	3.63	4.35	5.07	5.78	6.50	7.22	7.94	8.65
$500.01-1000.	2.20	2.92	3.63	4.35	5.07	5.78	6.50	7.22	7.94	8.65
OVER $1000.00	0.68	1.39	2.11	2.83	3.54	4.26	4.98	5.70	6.41	7.13

TEXTILE

UNIT PRICE \ REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
$0.01-$3.43	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$3.44-$5.00	5.42	6.35	7.27	8.20	9.13	10.06	10.99	11.92	12.85	13.78
$5.00-10.00	3.68	4.61	5.54	6.47	7.40	8.33	9.26	10.18	11.11	12.04
$10.01-25.00	3.29	4.22	5.15	6.07	7.00	7.93	8.86	9.79	10.72	11.65
$25.01-50.00	2.34	3.27	4.20	5.13	6.06	6.99	7.92	8.84	9.77	10.70
$50.01-$100.	2.34	3.27	4.20	5.13	6.06	6.99	7.92	8.84	9.77	10.70
$100.01-500.	2.34	3.27	4.20	5.13	6.06	6.99	7.92	8.84	9.77	10.70
$500.01-1000.	2.34	3.27	4.20	5.13	6.06	6.99	7.92	8.84	9.77	10.70
OVER $1000.00	2.34	3.27	4.20	5.13	6.06	6.99	7.92	8.84	9.77	10.70

ECONOMIC RETENTION LIMITS
GENERATED USING
REGRESSION RESULTS
DISPOSAL COST = $5.31

CONSTRUCTION COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	3.83	4.55	5.28	6.01	6.73	7.46	8.19	8.91	9.64	10.37
$50.00-$100.	3.02	3.75	4.48	5.20	5.93	6.66	7.39	8.11	8.84	9.57
$100.01-500.	2.48	3.21	3.94	4.66	5.39	6.12	6.84	7.57	8.30	9.02
$500.01-1000.	2.21	2.94	3.67	4.39	5.12	5.85	6.57	7.30	8.03	8.76
OVER $1000.00	2.21	2.94	3.67	4.39	5.12	5.85	6.57	7.30	8.03	8.76

ELECTRONICS COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	4.30	5.04	5.78	6.52	7.26	8.00	8.75	9.49	10.23	10.97
$50.00-$100.	3.29	4.03	4.77	5.51	6.25	6.99	7.73	8.48	9.22	9.96
$100.01-500.	2.45	3.19	3.93	4.68	5.42	6.16	6.90	7.64	8.38	9.12
$500.01-1000.	1.88	2.62	3.36	4.10	4.84	5.58	6.32	7.06	7.81	8.55
OVER $1000.00	1.88	2.62	3.36	4.10	4.84	5.58	6.32	7.06	7.81	8.55

GENERAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	4.59	5.28	5.97	6.66	7.35	8.04	8.73	9.42	10.11	10.80
$50.00-$100.	3.68	4.37	5.05	5.74	6.43	7.12	7.81	8.50	9.19	9.88
$100.01-500.	2.75	3.44	4.13	4.81	5.50	6.19	6.88	7.57	8.26	8.95
$500.01-1000.	2.20	2.89	3.58	4.27	4.96	5.65	6.34	7.03	7.72	8.41
OVER $1000.00	2.20	2.89	3.58	4.27	4.96	5.65	6.34	7.03	7.72	8.41

INDUSTRIAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	7.13	7.64	8.14	8.65	9.16	9.66	10.17	10.68	11.18	11.69
$50.00-$100.	5.43	5.94	6.45	6.95	7.46	7.97	8.47	8.98	9.49	9.99
$100.01-500.	4.15	4.66	5.17	5.67	6.18	6.69	7.19	7.70	8.21	8.71
$500.01-1000.	3.24	3.75	4.25	4.76	5.27	5.77	6.28	6.79	7.29	7.80
OVER $1000.00	2.45	2.95	3.46	3.97	4.47	4.98	5.49	5.99	6.50	7.01

MEDICAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	3.12	3.79	4.47	5.14	5.81	6.48	7.16	7.83	8.50	9.18
$50.00-$100.	3.12	3.79	4.47	5.14	5.81	6.48	7.16	7.83	8.50	9.18
$100.01-500.	3.12	3.79	4.47	5.14	5.81	6.48	7.16	7.83	8.50	9.18
$500.01-1000.	3.12	3.79	4.47	5.14	5.81	6.48	7.16	7.83	8.50	9.18
OVER $1000.00	1.25	1.93	2.60	3.27	3.94	4.62	5.29	5.96	6.64	7.31

TEXTILE COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$29.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
$29.01-$50.	3.33	4.22	5.11	6.00	6.88	7.77	8.66	9.55	10.43	11.32
$50.00-$100.	3.33	4.22	5.11	6.00	6.88	7.77	8.66	9.55	10.43	11.32
$100.01-500.	2.23	3.11	4.00	4.89	5.78	6.66	7.55	8.44	9.32	10.21
$500.01-1000.	1.33	2.22	3.11	4.00	4.88	5.77	6.66	7.55	8.43	9.32
OVER $1000.00	1.33	2.22	3.11	4.00	4.88	5.77	6.66	7.55	8.43	9.32

APPENDIX D (CONT.)

Regression Tables

Economic Returns Limits

ECONOMIC RETURNS LIMITS
GENERATED USING
REGRESSION RESULTS
DISPOSAL COST = $0.67
RETURN COST = $2.05

CONSTRUCTION COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	3.48	4.23	4.98	5.73	6.48	7.23	7.98	8.73	9.49	10.23
$5.01-$10.00	3.46	4.21	4.96	5.71	6.46	7.21	7.96	8.71	9.46	10.21
$10.01-$25.	3.20	3.95	4.70	5.45	6.20	6.95	7.70	8.45	9.20	9.95
$25.01-$50.	2.72	3.47	4.22	4.97	5.72	6.47	7.22	7.97	8.72	9.47
$50.00-$100.	2.47	3.22	3.97	4.72	5.47	6.22	6.97	7.72	8.47	9.22
$100.01-500.	2.28	3.03	3.78	4.53	5.28	6.03	6.78	7.53	8.28	9.03
$500.01-1000.	2.08	2.83	3.58	4.33	5.08	5.83	6.58	7.33	8.08	8.83
OVER $1000.00	2.08	2.83	3.58	4.33	5.08	5.83	6.58	7.33	8.08	8.83

ELECTRONICS COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	4.48	5.24	6.00	6.76	7.52	8.28	9.04	9.80	10.56	11.32
$5.01-$10.00	4.10	4.86	5.62	6.38	7.14	7.90	8.66	9.42	10.18	10.94
$10.01-$25.	3.62	4.38	5.14	5.90	6.66	7.42	8.18	8.94	9.71	10.47
$25.01-$50.	3.05	3.81	4.57	5.33	6.09	6.85	7.61	8.37	9.13	9.89
$50.00-$100.	2.74	3.50	4.26	5.02	5.78	6.54	7.30	8.06	8.82	9.58
$100.01-500.	2.32	3.08	3.84	4.60	5.36	6.12	6.88	7.64	8.40	9.16
$500.01-1000.	1.93	2.69	3.45	4.22	4.98	5.74	6.50	7.26	8.02	8.78
OVER $1000.00	1.93	2.69	3.45	4.22	4.98	5.74	6.50	7.26	8.02	8.78

GENERAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	4.58	5.27	5.97	6.67	7.36	8.06	8.75	9.45	10.15	10.84
$5.01-$10.00	4.02	4.71	5.41	6.11	6.80	7.50	8.19	8.89	9.59	10.28
$10.01-$25.	3.84	4.54	5.23	5.93	6.63	7.32	8.02	8.71	9.41	10.11
$25.01-$50.	3.20	3.89	4.59	5.29	5.98	6.68	7.37	8.07	8.77	9.46
$50.00-$100.	2.96	3.65	4.35	5.04	5.74	6.44	7.13	7.83	8.52	9.22
$100.01-500.	2.49	3.18	3.88	4.58	5.27	5.97	6.66	7.36	8.06	8.75
$500.01-1000.	2.15	2.85	3.54	4.24	4.94	5.63	6.33	7.02	7.72	8.42
OVER $1000.00	2.06	2.76	3.45	4.15	4.85	5.54	6.24	6.93	7.63	8.33

INDUSTRIAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	5.42	6.08	6.74	7.40	8.06	8.72	9.38	10.04	10.70	11.37
$5.01-$10.00	5.00	5.66	6.32	6.98	7.64	8.31	8.97	9.63	10.29	10.95
$10.01-$25.	4.44	5.10	5.76	6.42	7.08	7.74	8.40	9.07	9.73	10.39
$25.01-$50.	3.88	4.54	5.20	5.86	6.52	7.18	7.85	8.51	9.17	9.83
$50.00-$100.	3.14	3.80	4.47	5.13	5.79	6.45	7.11	7.77	8.43	9.09
$100.01-500.	2.14	2.81	3:47	4.13	4.79	5.45	6.11	6.77	7.43	8.09
$500.01-1000.	1.36	2.02	2.68	3.34	4.01	4.67	5.33	5.99	6.65	7.31
OVER $1000.00	0.17	0.83	1.49	2.15	2.82	3.48	4.14	4.80	5.46	6.12

MEDICAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	3.31	4.03	4.75	5.46	6.18	6.90	7.61	8.33	9.05	9.76
$5.01-$10.00	2.73	3.45	4.16	4.88	5.60	6.31	7.03	7.75	8.46	9.18
$10.01-$25.	2.85	3.57	4.28	5.00	5.72	6.43	7.15	7.87	8.58	9.30
$25.01-$50.	2.76	3.48	4.20	4.91	5.63	6.35	7.06	7.78	8.50	9.21
$50.00-$100.	2.35	3.07	3.78	4.50	5.22	5.93	6.65	7.37	8.08	8.80
$100.01-500.	2.11	2.83	3.55	4.26	4.98	5.70	6.41	7.13	7.85	8.56
$500.01-1000.	2.04	2.76	3.48	4.19	4.91	5.63	6.34	7.06	7.78	8.49
OVER $1000.00	0.68	1.40	2.12	2.83	3.55	4.27	4.98	5.70	6.42	7.13

TEXTILE COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	3.18	4.05	4.92	5.79	6.66	7.53	8.40	9.26	10.13	11.00
$5.01-$10.00	3.07	3.94	4.81	5.68	6.55	7.42	8.29	9.16	10.03	10.99
$10.01-$25.	3.11	3.98	4.85	5.72	6.59	7.46	8.33	9.20	10.07	10.94
$25.01-$50.	2.41	3.28	4.15	5.02	5.89	6.76	7.63	8.50	9.37	10.23
$50.00-$100.	2.41	3.28	4.15	5.02	5.89	6.76	7.63	8.50	9.37	10.23
$100.01-500.	2.41	3.28	4.15	5.02	5.89	6.76	7.63	8.50	9.37	10.23
$500.01-1000.	2.41	3.28	4.15	5.02	5.89	6.76	7.63	8.50	9.37	10.23
OVER $1000.00	2.41	3.28	4.15	5.02	5.89	6.76	7.63	8.50	9.37	10.23

ECONOMIC RETURNS LIMITS
GENERATED USING
REGRESSION RESULTS
DISPOSAL COST = $5.31
RETURN COST = $10.22

CONSTRUCTION

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	2.86	3.57	4.28	4.99	5.70	6.41	7.12	7.83	8.54	9.26
$5.01-$10.00	2.86	3.57	4.28	4.99	5.70	6.41	7.12	7.83	8.54	9.26
$10.01-$25.	2.78	3.49	4.20	4.91	5.62	6.33	7.04	7.75	8.46	9.17
$25.01-$50.	2.60	3.31	4.02	4.73	5.44	6.15	6.86	7.57	8.28	8.99
$50.00-$100.	2.46	3.17	3.88	4.59	5.30	6.01	6.72	7.43	8.14	8.85
$100.01-500.	2.35	3.06	3.77	4.48	5.19	5.90	6.61	7.32	8.04	8.75
$500.01-1000.	2.26	2.97	3.68	4.39	5.10	5.81	6.52	7.23	7.94	8.65
OVER $1000.00	2.16	2.87	3.58	4.29	5.00	5.71	6.42	7.13	7.84	8.55

ELECTRONICS

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	3.64	4.35	5.06	5.77	6.48	7.19	7.90	8.61	9.33	10.04
$5.01-$10.00	3.48	4.19	4.91	5.62	6.33	7.04	7.75	8.46	9.17	9.88
$10.01-$25.	3.19	3.90	4.61	5.32	6.03	6.74	7.45	8.17	8.88	9.59
$25.01-$50.	2.95	3.66	4.37	5.09	5.80	6.51	7.22	7.93	8.64	9.35
$50.00-$100.	2.75	3.46	4.17	4.88	5.59	6.31	7.02	7.73	8.44	9.15
$100.01-500.	2.45	3.17	3.88	4.59	5.30	6.01	6.72	7.43	8.14	8.85
$500.01-1000.	2.17	2.88	3.59	4.30	5.01	5.72	6.43	7.14	7.86	8.57
OVER $1000.00	2.17	2.88	3.59	4.30	5.01	5.72	6.43	7.14	7.86	8.57

GENERAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	3.81	4.45	5.09	5.73	6.38	7.02	7.66	8.30	8.95	9.59
$5.01-$10.00	3.52	4.16	4.80	5.44	6.09	6.73	7.37	8.01	8.66	9.30
$10.01-$25.	3.47	4.11	4.75	5.39	6.04	6.68	7.32	7.96	8.61	9.25
$25.01-$50.	3.14	3.78	4.43	5.07	5.71	6.35	7.00	7.64	8.28	8.92
$50.00-$100.	2.99	3.63	4.28	4.92	5.56	6.20	6.85	7.49	8.13	8.77
$100.01-500.	2.71	3.35	3.99	4.63	5.28	5.92	6.56	7.20	7.85	8.49
$500.01-1000.	2.43	3.07	3.72	4.36	5.00	5.64	6.29	6.93	7.57	8.21
OVER $1000.00	2.38	3.02	3.66	4.31	4.95	5.59	6.23	6.88	7.52	8.16

INDUSTRIAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	4.59	5.19	5.79	6.38	6.98	7.58	8.18	8.77	9.37	9.97
$5.01-$10.00	4.48	5.08	5.68	6.27	6.87	7.47	8.07	8.66	9.26	9.86
$10.01-$25.	4.18	4.78	5.38	5.97	6.57	7.17	7.77	8.37	8.96	9.56
$25.01-$50.	3.88	4.47	5.07	5.67	6.27	6.87	7.46	8.06	8.66	9.26
$50.00-$100.	3.40	3.99	4.59	5.19	5.79	6.38	6.98	7.58	8.18	8.78
$100.01-500.	2.62	3.21	3.81	4.41	5.01	5.61	6.20	6.80	7.40	8.00
$500.01-1000.	1.86	2.46	3.06	3.65	4.25	4.85	5.45	6.04	6.64	7.24
OVER $1000.00	1.09	1.69	2.29	2.89	3.48	4.08	4.68	5.28	5.88	6.47

MEDICAL COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	2.72	3.39	4.06	4.74	5.41	6.08	6.76	7.43	8.10	8.78
$5.01-$10.00	2.72	3.39	4.06	4.74	5.41	6.08	6.76	7.43	8.10	8.78
$10.01-$25.	2.72	3.39	4.06	4.74	5.41	6.08	6.76	7.43	8.10	8.78
$25.01-$50.	2.72	3.39	4.06	4.74	5.41	6.08	6.76	7.43	8.10	8.78
$50.00-$100.	2.72	3.39	4.06	4.74	5.41	6.08	6.76	7.43	8.10	8.78
$100.01-500.	2.25	2.93	3.60	4.27	4.95	5.62	6.29	6.97	7.64	8.31
$500.01-1000.	2.25	2.93	3.60	4.27	4.95	5.62	6.29	6.97	7.64	8.31
OVER $1000.00	1.24	1.92	2.59	3.26	3.94	4.61	5.29	5.96	6.63	7.31

TEXTILE COMMODITY

REMAINING LIFE:	2	4	6	8	10	12	14	16	18	20
UNIT PRICE										
0.01-$5.00	2.72	3.53	4.33	5.14	5.94	6.75	7.56	8.36	9.17	9.97
$5.01-$10.00	2.72	3.53	4.33	5.14	5.94	6.75	7.56	8.36	9.17	9.97
$10.01-$25.	2.72	3.53	4.33	5.14	5.94	6.75	7.56	8.36	9.17	9.97
$25.01-$50.	2.36	3.17	3.97	4.78	5.58	6.39	7.20	8.00	8.81	9.61
$50.00-$100.	2.36	3.17	3.97	4.78	5.58	6.39	7.20	8.00	8.81	9.61
$100.01-500.	2.36	3.17	3.97	4.78	5.58	6.39	7.20	8.00	8.81	9.61
$500.01-1000.	1.40	2.20	3.01	3.81	4.62	5.43	6.23	7.04	7.84	8.65
OVER $1000.00	1.40	2.20	3.01	3.81	4.62	5.43	6.23	7.04	7.84	8.65

APPENDIX E

ESTIMATED REMAINING LIFE
BASED UPON
CURRENT SYSTEM LIFE

CURRENT SYSTEM LIFE(YRS)	COMMODITY C	E	I	G	M	T
1	15	13	12	13	8	8
2	14	12	11	12	10	10
3	13	11	11	11	10	10
4	12	11	10	10	9	9
5	11	10	10	10	9	9
6	11	9	9	9	9	9
7	10	8	8	8	8	8
8	9	7	7	7	8	8
9	8	6	7	7	7	7
10	8	6	7	6	6	6
11	7	6	6	6	6	6
12	7	6	6	5	5	5
13	6	6	5	5	5	5
14	5	5	5	4	4	4
15	5	5	4	4	3	3
16	4	5	4	4	3	3
17	3	4	3	3	3	3
18	3	4	3	3	3	3
19	2	3	2	3	3	3
20	2	2	2	2	2	2
21	1	2	1	1	2	2
22	1	1	1	1	2	2
23	1	1	1	1	1	1
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	-	1	2	1	1	1
27	-	-	-	-	-	-
28	1	1	-	-	-	-
29	-	1	3	-	-	-
30	-	-	-	-	-	-
31	-	-	1	-	-	-
32	-	-	1	-	-	-
33	-	-	1	-	-	-

- no observations

APPENDIX F

References

1. DODI 4100.37, Retention and Transfer of Materiel Assets, 12 November 1981.

2. DLAM 4140.3, Materiel Management Manual, Cameron Station, VA, January 1979.

3. DoD Materiel Returns Study, Interim Report, DLA-LO, Cameron Station, Alexandria, Virginia, April 1986.

4. Cost to Order Study, DLA-LO, Cameron Station, Alexandria, Virginia, May 1984.

5. Economic Retention/Returns Limit Study, DLA-LOO, Cameron Station, Alexandria, Virginia, August 1978.